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(54) Title: WATER DISPERSIBLE CORROSION INHIBITOR

(57) **Abstract:** An environmentally benign and water dispersible corrosion inhibitor is disclosed. The corrosion inhibitor comprises a combination obtained by combining at least one of water dispersible polymers, water soluble silicates, water, additives, among other components.



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5 WATER DISPERSIBLE CORROSION INHIBITOR

The subject matter disclosed and claimed herein claims benefit of prior filed U.S. Patent Application Serial No. 60/246,886, filed on November 08, 2001; the disclosure of which is hereby incorporated by reference.

10 FIELD OF THE INVENTION

The field of the invention relates to corrosion inhibitors for reducing the corrosion rate of metallic surfaces.

15 BACKGROUND OF THE INVENTION

It is well know in this art to apply one or more inhibitors upon a metallic surface to reduce the corrosion rate. Conventional corrosion inhibitors typically contain components that are environmentally desirable. Such components are partiuarally undesirable when employed in applications wherein the components may be released upon water or other environmentally sensitive areas.

20 SUMMARY OF THE INVENTION

The instant invention solves problems associated with conventional methods by providing an environmentally benign and water dispersible corrosion inhibitor. The inventive corrosion inhibitor comprises a combination obtained by combining at least one of water dispersible polymers, water soluble silicates, water, additives, among other components. The inventive composition is typically employed in applications were relatively short term (depending upon the application) corrosion inhibition is desired. The inventive composition and process can also be employed for increasing the effective life of metallic surfaces previously treated to impart relatively long term corrosion protection, e.g., painted metallic surfaces.

30 DETAILED DESCRIPTION

The instant invention relates to compositions, and method for applying the composition to reduce dusting and/or corrosion of a metallic surface. The metallic surface can comprise an anchor chain such as that used on commercial and military boats and ships. The chain can

comprise detachable links such as those described in U.S. Patent No. 5,974,779, issued Nov. 02, 1999 in the named of Orscheln et al.; hereby incorporated by reference.

While the inventive composition can comprise a wide range of components, normally the composition is substantially free of toxic components and those leaving a film or sheen upon water.

5 By "substantially free" it is meant that the composition comprises less than about 10 wt.% and normally about 0 wt.% of such components.

The inventive method can be employed to apply the inventive composition(s) in order to:

- 1) Use silicates and salt water for corrosion inhibition of metal on ocean vessels or platforms,
- 2) Use polyvinyl alcohol or silicate blends for corrosion control,
- 10 3) Use polyvinyl alcohol as a rust binder for anchor chain or other metal structure,
- 4) Use silicates as rust binder for anchor chain or other metal structures,
- 5) Use silicate solutions as deck or platform wash using salt water diluent, among other applications wherein it is desirable to inhibit corrosion.

In one aspect of the invention, the inventive composition comprises at least one of polyvinyl alcohol, ethylene vinyl acetate (and copolymers) thereof, among other water soluble or dispersible and non-toxic polymeric compounds, and water. Normally, the polymeric compound comprises polyvinyl alcohol. The amount of water in the inventive composition normally ranges from about 70 to at least 90 wt.%. If desired, the water can comprise salt water including naturally occurring brackish and ocean/sea water (e.g., water comprising about 5 to at least 7 wt.% sodium chloride).

20 The composition of this aspect of the invention is particularly effective at controlling release of dust and debris from a corroded or rusted surface. If desired, the inventive composition can further comprise at least one de-foaming compound, e.g., a silicon modified dispersion of olefinic solids. The inventive composition can be applied upon an anchor chain (e.g., as the chain is being hoisted and placed into a storage locker upon a boat or ship), in order to reduce, if not eliminate, rust and debris from being released into the air when the anchor is redeployed from the storage locker.

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In a second aspect of the invention, the inventive composition comprises at least one water soluble silicate, e.g., sodium silicate, potassium silicate, among other water dispersible silicates, and water. Normally, the water soluble silicate comprises sodium silicate (e.g., density ratio 3:22). The amount of water in the inventive composition normally ranges from about 70 to at least 90 wt.%. If desired, the water can comprise salt water including naturally occurring brackish and salt water (e.g., water comprising about 5 to at least 7 wt.% sodium chloride). The composition has a relatively high pH that ranges from about 8 to about 12, e.g., normally about 11. In general, the higher the pH the greater the effectiveness of the composition at reducing corrosion. If desired at least one pH modifying compound can be added to the composition, e.g., sodium hydroxide. The

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composition of this aspect of the invention is particularly effective at controlling release of dust and debris from a corroded or rusted surface as well as reducing the rate of continued corrosion. The inventive composition can be applied upon an anchor chain (e.g., as the chain is being hoisted and placed in a storage locker), in order to reduce corrosion during storage and reduce, if not  
5 eliminate, rust and debris from being released into the air when the anchor is redeployed from the storage locker.

The inventive composition can further comprise at least one additive such as defoaming agents, anti-microbial, surfactants, anti-freeze, dyes, thickeners, among other components. Examples of a suitable anti-freeze materials are propylene glycol, methanol, among others. Using  
10 environment friendly materials is desirable for applications wherein the composition directly contacts water. An example of suitable defoaming agent comprise silicone based agents.

The inventive composition can be prepared by combining the components by using any suitable method. Examples of suitable methods comprise hand mixing, agitation, spray mix heads, among other methods known in the art. The combination rate can be enhanced by heating, e.g.,  
15 180 F for a period of about 30 minutes. In some cases, the composition forms an emulsion.

The inventive composition can be applied upon a desired surface by using any suitable method. Examples of suitable methods comprise dipping, immersing, spraying, wiping, among other delivery methods known in this art. In some cases, it is desirable to prepare a concentrate or an intermediate comprising all components of the inventive composition except water (e.g., salt  
20 water). The intermediate is then combined with a readily available source of water (e.g., ocean water in the case of a marine vessel or structure), and applied upon the desired surface. If desired, the intermediate comprises all of the components wherein only a portion of the water (e.g., tap or potable water) is present and remainder of the water (e.g., salt water) is added in situ prior to usage.

While the above description has emphasized using the inventive composition on marine  
25 applications, the compositions can be employed on piers (e.g., as a wash and protectant for concrete), pipe flanges and joints before or after welding, as water blast additive for pipe or flange cleaning and repair, temporary coatings during shipment of metallic articles and intermediates (e.g., coil steel, rod used for making wire rope and strand, among others), anchor chain lockers,  
30 wash for off-shore structures (e.g., oil rigs), among other applications.

## EXAMPLES

The following Examples are provided to illustrate certain aspects of the instant invention and shall not limit the scope of any claims appended hereto. The following Table lists the components that were used to prepare the aspects of the inventive composition test below.

Trade Name	Chemical Composition	Supplier
PQ GRADE G	Sodium silicate solid	PQ Corporation
PQ GRADE N	Sodium silicate liquid	PQ Corporation
AIRFLEX 500BP	Vinyl acetate emulsion	Air Products
AIRVOL 203S	Polyvinyl alcohol	Air Products
VINAC RP 710	Polyvinyl acetate	Air Products
DAPRO U-99	Anionic/non surfactant blend	Elementis
DAPRO DF 3163	Modified polyol foam suppressor	Elementis
DAPRO DF 1161	Silicon modified olefinic solids dispersion foam suppressor	Elementis

## FORMULATION 1

MATERIAL	AMOUNT
AIRVOL 203S	101.5g
H <sub>2</sub> O TAP	405cc
Preparation: MIXED ON HOTPLATE STIRRER @ 185°F FOR 30 MINUTES	

## FORMULATION 2

MATERIAL	AMOUNT
PQ GRADE G	10g
H <sub>2</sub> O TAP	390cc
Preparation: MIXED ON HOTPLATE STIRRER @ 190°F FOR 30 MINUTES	

## FORMULATION 3

MATERIAL	AMOUNT
AIRVOL 203S	150g
H <sub>2</sub> O TAP	350cc
Preparation: MIXED ON HOTPLATE STIRRER @ 190°F FOR 30 MINUTES	

## FORMULATION 4

MATERIAL	AMOUNT
PQ GRADE G	20g
H <sub>2</sub> O TAP	400cc
MIXING: MIXED ON HOTPLATE STIRRER @ 208°F FOR 30 MINUTES	

The following Table describes the Testing Parameters for the Formulations

DESCRIPTION:	Anchor chain coating for marine applications with the primary purpose of
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eliminating/reducing the iron oxide dust generated when anchor is dropped

PARAMETERS:	1.	Spray applied during conventional anchor wash down procedures that are employed when anchor is hoisted
	2.	Non-flammable.
	3.	Water based to allow coating to be incorporated into the current wash down equipment.
	4.	Can not leave oily film or sheen on water as the coating will likely go overboard during anchor wash down.
	5.	Can not leave long duration foam on water.
	6.	After coating dries, it must dissolve in salt water to prevent coating build up which could lead to flakes or debris floating on water when anchor is deployed or debris clogging chain locker drains.
	7.	No environmental hazards or impact.
	8.	Coating concentrate must be able to be diluted to working solution strength using sea water as this is what the Navy uses for wash down.
	9.	Coating can be applied using commercially available equipment.

### TESTING PARAMETER DESCRIPTIONS

1. **FOAMING:** This was a visual observation of foaming characteristics when spray applying the coating/protectant.
2. **DISSOLUTION TEST:** Formula being tested was applied to a bare steel panel and dried. Pigments and tension modifiers can be added to allow for a uniform coating (bare steel having a different surface tension than corroded steel) and to give a visual indication if coating dissolves. Coated panel was partially immersed in a 5% salt water solution. After 2 hours, coating was checked to see if it is or has dissolved. The water was also checked for film, flakes or oily sheen on the surface.
3. **RUB TEST:** 10 light double rubs with a white paper towel on a dry anchor chain link. The amount of rust on paper towel is rated from 0 to 5. 0 = no rust evident. 5 = rust on paper towel same as amount of rust rubbed off uncoated anchor chain (control).
4. **SALT FOG:** Bare clean chain was coated, allowed to dry and placed into salt fog chamber. The type of chain, coating method, and time in chamber will be noted. Results were compared against uncoated chain of same type (control). Rating is from 1 to 5. 1 = more corrosion than control, 2 = slightly more, 3 = same as control, 4 = slightly less, 5 = less than control
5. **HUMIDITY:** Bare clean chain was coated, allowed to dry and placed in a 100F oven onto a perforated plastic shelf that is directly above a pan of water. Results were compared against uncoated chain of same type (control). Rating is from 1 to 5. 1 = more corrosion than control, 2 = slightly more, 3 = same as control, 4 = slightly less, 5 = less than control

FORMULATION EVALUATION  
TABLE A

FORMULATION COMPONENTS	Trial Number			
	001	002	003	004
PQ GRADE G	15			
AIRFLEX 500 BP		50		
AIRVOL 203S			15	
VINAC RP710				15
H <sub>2</sub> O DISTILLED	100			
H <sub>2</sub> O TAP		50	100	100 HOT
5% SALT WATER				
<b>TESTS</b>				
DISSOLUTION TEST			DISSOLVED, NO FLAKES,	

FOAMING			FILM OR OILY SHEEN ON WATER	
RUST RUB OFF			FOAMS ON SPRAYING	
MIXING	STIRRED BY HAND	STIRRED BY HAND	MIXED ON HOTPLATE/STIRRER. HEAT SETTING = 2.5 SPEED = 6 FOR 30 MINUTES	STIRRED BY HAND
APPLICATION	DIP COAT, HANGER CHAIN	DIP COAT, HANGER CHAIN	DUST TEST - COATING APPLIED USING GARDEN SPRAYER SET TO 80Z/GALLON DISSOLUTION - FOAM BRUSH, STEEL PANEL	

FORMULATION EVALUATION  
TABLE B

FORMULATION COMPONENTS	Trial Number			
	005	006	007	008
PQ GRADE G				
AIRFLEX 500 BP		0.3		
AIRVOL 203S				
VINAC RP710				
Formulation 1	20	2	80	
Formulation 2		1	20	
Formulation 3				100
DAPRO U-99		0.07		
DAPRO DF 3163	.25	0.07	1	0.5
H <sub>2</sub> O DISTILLED				
H <sub>2</sub> O TAP	10			
5% SALT WATER				
TESTS				
DISSOLUTION TEST		NO DISSOLUTION		
FOAMING	FOAMS BUT DISSIPATES QUICKLY			
RUST RUB OFF			BETTER THAN CONTROL BUT NOT RATED	POOR - SAME AS CONTROL BUT NOT RATED
MIXING	MIXED BY HAND	ALL INGREDIENTS ADDED TO TEST TUBE AND SHAKEN BY HAND	MIXED BY HAND	MIXED BY HAND
APPLICATION	GARDEN SPRAYER SET AT 80Z/GALLON.	FOAM BRUSH, BARE STEEL	GARDEN SPRAYER SET AT 80Z/GALLON. SALTWATER SOAKED RUSTED ANCHOR CHAIN. COATED WHILE STILL WET	GARDEN SPRAYER SET AT 80Z/GALLON. SALTWATER SOAKED RUSTED ANCHOR CHAIN. COATED WHILE STILL WET
COMMENTS	NO SUBSTRATE COATED, FOAMING OBSERVATION ONLY	MIXTURE IS STABLE. THIS WAS TO TEST THE STABILITY OF 500BP IN A PVA SOLUTION AND IF IT ALSO AFFECTED THE COATING SOLUBILITY	BETTER THAN CONTROL ON RUB TEST BUT NOT AS GOOD AS USING B001-0005 ALONE. WHEN B001-0005 ONLY WAS APPLIED THE SAME METHOD AS ABOVE WAS USED.	RELATIVELY HIGH

FORMULATION EVALUATION  
TABLE C

FORMULATION COMPONENTS				
		PVA (PolyVinyl Alcohol) RATIO STUDY	PVA RATIO STUDY	PVA RATIO STUDY
PQ GRADE G				
AIRFLEX 500 BP				
AIRVOL 203S	100			
VINAC RP710				
Formulation 1		NEAT	10	10
Formulation 2				
Formulation 3				
DAPRO U-99				
DAPRO DF 3163				
DAPRO DF 1161	2			
H <sub>2</sub> O DISTILLED				
H <sub>2</sub> O TAP	300		10	20
5% SALT WATER				

TESTS				
RUST RUB OFF	MODERATE, BETTER THAN 008 BUT NOT AS GOOD AS USING B001-0005 IN A 8OZ/GALLON RATIO. NOT RATED.	RATING = 0	RATING = 0	RATING = 1
MIXING				
	MIXED ON HOTPLATE STIRRER @ 190°F FOR 30 MIN.	NO MIX, APPLIED NEAT	MIXED BY HAND	MIXED BY HAND
APPLICATION				
	DILUTED WITH WATER TO GIVE A 9g PVA PER GALLON. DILUTED 009 WAS PLACED INTO A GRACO SPRAY GUN AND SPRAYED ONTO A WET ANCHOR CHAIN THAT HAD BEEN IMMERSERD IN A 3% SALT WATER SOLUTION	FOAM BRUSH APPLIED TO A DRY RUSTED ANCHOR CHAIN LINK. DRIED USING HEAT GUN	FOAM BRUSH APPLIED TO A DRY RUSTED ANCHOR CHAIN LINK. DRIED USING HEAT GUN	FOAM BRUSH APPLIED TO A DRY RUSTED ANCHOR CHAIN LINK. DRIED USING HEAT GUN
COMMENTS				
	SOLUTION HAS THE SAME RATIO THAT WAS ATTEMPTED WITH 008 IN THE 8OZ/GALLON SPRAYER..	STUDY TO DETERMINE THE AMOUNT OF PVA NEEDED TO PRODUCE AN ACCEPTABLE COATING. B001-0005 NEAT EQUATES TO 2g PVA / 8cc H <sub>2</sub> O	STUDY TO DETERMINE THE AMOUNT OF PVA NEEDED TO PRODUCE AN ACCEPTABLE COATING. 10g OF B001-0005 DILUTED WITH 10cc OF H <sub>2</sub> O EQUATES TO 2g OF PVA TO 18cc H <sub>2</sub> O	STUDY TO DETERMINE THE AMOUNT OF PVA NEEDED TO PRODUCE AN ACCEPTABLE COATING. 10g OF B001-0005 DILUTED WITH 20cc OF H <sub>2</sub> O EQUATES TO 2g OF PVA TO 28cc H <sub>2</sub> O

FORMULATION EVALUATION  
TABLE D

FORMULATION COMPONENT	PVA RATIO STUDY	010	011	012
PQ GRADE G				
AIRFLEX 500 BP				
AIRVOL 203S		40	40	40
VINAC RP710				
Formulation 1	10			
Formulation 2				
Formulation 3				
Formulation 4				300
DAPRO U-99				
DAPRO DF 3163				
DAPRO DF 1161		1	1	1
H <sub>2</sub> O DISTILLED				
H <sub>2</sub> O TAP	52	300	300	
5% SALT WATER				
TESTS				
RUST RUB OFF	RATING = 1	RATING = 1	RATING = 1	
SALT FOG		16 HOURS, RATING = 3		
MIXING				
	MIXED BY HAND	MIXED ON HOTPLATE STIRRER @ 190°F FOR 30 MIN	MIXED ON HOTPLATE STIRRER @ 190°F FOR 30 MIN	MIXED ON HOTPLATE STIRRER @ 190°F FOR 30 MIN
APPLICATION				
	FOAM BRUSH APPLIED TO A DRY RUSTED ANCHOR CHAIN LINK. DRIED USING HEAT GUN	RUB TEST - DILUTED AND APPLIED USING A PRESSURE SPRAYER TO A WET RUSTED ANCHOR CHAIN LINK THAT HAD BEEN IMMERSERD IN A 3% SALT WATER SOLUTION. CHAIN WAS ALLOWED TO AIR DRY. SALT FOG - DILUTED AND DIP APPLIED TO BARE CLEAN HANGER CHAIN AND ALLOWED TO DRY THEN PLACED INTO SALT FOG ALONG WITH AND UNCOATED HANGER CHAIN	DILUTED AND APPLIED USING A PRESSURE SPRAYER TO A WET RUSTED ANCHOR CHAIN LINK THAT HAD BEEN IMMERSERD IN A 3% SALT WATER SOLUTION. CHAIN WAS ALLOWED TO AIR DRY.	NOT TESTED
COMMENTS				
	STUDY TO DETERMINE THE AMOUNT OF PVA NEEDED TO PRODUCE AN ACCEPTABLE COATING. 10g OF B001-0005 DILUTED WITH 52cc OF H <sub>2</sub> O EQUATES TO 1g OF PVA TO 30cc H <sub>2</sub> O	DILUTED WITH 900cc H <sub>2</sub> O EQUATES TO 1g OF PVA TO 30cc H <sub>2</sub> O. THE RUB TEST IS ACCEPTABLE.	DILUTED WITH 900cc OF 5% SALT WATER. THIS IS THE SAME BATCH AS 010 BUT SALT WATER IS USED AS THE DILUENT TO CHECK IT EFFECT ON SOLUTION STABILITY AND COATING PERFORMANCE. SOLUTION IS STABLE AND PERFORMANCE IS SAME AS 010.	

FORMULATION EVALUATION  
TABLE E



FORMULATION COMPONENT	Trial Number			
	013	014		
PQ GRADE G				
PQ GRADE N (liquid)	100	300		
AIRVOL 203S				
VINAC RP710				
Formulation 1				
Formulation 2				
Formulation 3				
Formulation 4				
DAPRO U-99				
DAPRO DF 3163				
DAPRO DF 1161				
H <sub>2</sub> O DISTILLED				
H <sub>2</sub> O TAP				
5% SALT WATER		300		
<b>TESTS</b>				
RUST RUB OFF	RATING = 0	RATING = 1		
SALT FOG		RATING = 1		
<b>MIXING</b>				
	NONE, USED NEAT	MIXED BY HAND		
<b>APPLICATION</b>				
	FOAM BRUSH APPLIED TO DRY RUSTED ANCHOR CHAIN, DRIED WITH HEAT GUN	RUB TEST - APPLIED USING A PRESSURE SPRAYER TO A WET RUSTED ANCHOR CHAIN LINK THAT HAD BEEN IMMERSSED IN A 3% SALT WATER SOLUTION. CHAIN WAS ALLOWED TO AIR DRY. SALT FOG - APPLIED USING A PRESSURE SPRAYER TO CLEAN BARE HANGER CHAIN AND ALLOWED TO DRY		
<b>COMMENTS</b>				
	ANCHOR CHAIN HAS SURFACE CORROSION AND PITTING BUT LITTLE SCALE. COATINGS SEEM TO SOAK INTO THIS TYPE OF SURFACE.	DILUTED WITH SALT WATER		

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THE FOLLOWING IS CLAIMED:

- 1) A composition comprising a combination comprising at least one water dispersible polymer selected from the group consisting of vinyl acetate, vinyl acetate  
10 copolymers, vinyl acetate emulsion, polyvinyl acetate and polyvinyl alcohol, water and at least one additive.
- 2) A composition comprising a combination comprising polyvinyl alcohol, at least one silicon containing foam suppressant, water, and sodium chloride.
- 15 3) The composition of Claim 1 wherein the water comprises naturally occurring salt containing water.
- 4) The composition of Claim 2 wherein the water comprises naturally occurring salt  
20 containing water.
- 5) The composition of Claim 1 further comprising at least one water soluble silicate.
- 6) The composition of Claim 2 further comprising at least one water soluble silicate.
- 25 7) The composition of Claim 1 wherein said composition has a basic pH.
- 8) The composition of Claim 2 wherein said composition has a basic pH.
- 9) The composition of Claim 1 wherein said water dispersible polymer comprises at  
30 least one of vinyl acetate and copolymers thereof.
- 10) The composition of Claim 1 wherein said water dispersible polymer comprises  
35 at least one vinyl acetate emulsion.